wards behind the ears. The fur of the body is short; the tail is clothed with coarse short fur from which long hairs arise; the feet are covered with short hairs of which the longest are at the bases of the claws, which they nearly equal in length.

Both the upper and lower anterior incisors are remarkably long (see Monograph of the Insectivora, pt. iii. fasc. i. pl. xxvii. fig. 3), the upper anterior incisor has a short basal cusp which does not extend even below the cingulum of the second incisor. Viewed laterally the third incisor is very little smaller than the anterior maxillary tooth; but seen from beneath the latter much exceeds the former in cross section at the base, and its cusp very slightly exceeds the anterior basal cusp of the premolar; its base is not emarginate posteriorly as in *C. Strauchii*. The anterior lower incisor has a shallow notch for the posterior basal cusp of the anterior upper incisor.

Length, head and body, 68 millim., tail 46, eye from tip of nostril 14, length of ear $8\frac{1}{2}$, elbow to end of middle digit 19, manus $8\frac{1}{2}$, pes 14, tibia 14, distance of the tip of first incisor from apex of principal cusp of the last premolar $5\frac{1}{2}$.

Type, preserved in alcohol, No. 1968, in the collection of the Zoological Museum at St. Petersburg.

XXXIV.—*On the Constitution of the Body in the* Blattidæ.

By E. Haase *.

Any extension of our knowledge of the structure of the Cockroaches, however small, is of special interest, because two characteristic representatives of this family of Orthoptera, the House-cockroach (*Phyllodromia germanica*, Fab.) and the Kitchen-cockroach (*Periplaneta orientalis*, Linn.), from their occurrence in the dwellings of man and their adaptation to this protective habitat, are to be obtained in abundance throughout the year, and further because, on account of their considerable size, they have always served as a chosen material for an introduction to the anatomy of insects.

But, moreover, the oldest remains of fossil insects known to us, the Silurian *Palæoblattina Durvillei*, Brongn. †, and

* Translated from the 'Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin,' Jahrg. 1889, pp. 128–136.

† F. Brauer sees in the preserved remains of the wing indications of a probably synthetic Orthopteron approaching the Mole-Cricket (Ann. k. k. Naturhist. Hofm. Wien, i. 1881, p. 1).

half of all the species known from the Carboniferous formation are to be referred to the Blattidæ.

As the gradual embryogeny of the insect-body distinctly shows, its constitution is to be carried back to the scheme which was drawn up by B. Hatschek * for the origin of the Annelid from the trochophore. But as the structure of the fully-developed insect-embryo is at the same time more sharply defined in its elements than in the case of the Annelida, Myriopoda, and Crustacea, and above all is subject to no variations in the number of its segments, it is desirable to modify somewhat Hatschek's more generally applied denominations of the constituents of the body for the Hexapoda. Thus the expression "frontal piece" may be substituted for Hatschek's "head-segment," as this only forms the head of the insect in conjunction with the jaw-bearing metameres. Further, in consequence of the definitely fixed number of the abdominal segments in the developed embryo of insects, Hatschek's "end-segment" represents no indifferent terminal portion, as it does among Annelida, Crustacea, and many Myriopoda. By the complete suppression in the mature embryo of any indefinite anterior girdle acting as a gemmiparous zone there rather remains only of the terminal segment a terminal section incapable of further development of segments, which, as it bears the anal aperture, may be characterized as the "anal piece."

Consequently the body of the mature embryo of the House-cockroach consists (1) of a frontal piece which bears as a central process the labrum and as lateral appendages the antennary lobes, shows no primitive-vertebriform rudiments of the secondary body-cavity, and is perforated posteriorly by the orifice of the mouth. The originally ventral position of the antennæ, which has been so often cited in evidence of their limb-nature, probably only corresponds to the place of their first origin, and therefore does not carry with it their equivalence to the persistent ventral pedal appendages.

Behind the frontal piece comes (2) the definite number of true metameres, with bilateral, primitive-vertebral foundations of the secondary body-cavity and ventral pedal appendages. Of these segments the first three advance towards the frontal piece and their appendages become jaws; in this way the head of the insect is produced. Behind these follow three thoracic or mesosomatic segments, with the thoracic legs, and finally the abdomen, composed of ten true metameres, the early-indicated embryonic limbs of which soon disappear.

* Arbeit. Zool. Inst. Wien, i. (1878) p. 77.

The abdominal segments are closed (3) lastly by the "anal piece," into which neither the ventral cord nor the secondary body-cavity is continued, and which remarkably resembles the frontal piece. For on the "anal piece" are also two terminal appendages, originally quite ventral and lobiform, like the antennæ, afterwards with tentaculiform terminal appendages, although less developed and later in appearing than the antennæ, *the cerci*, which only subsequently move close to or above the anus.

Further, there is on the anal piece a median dorsal plate above the anus, the anal operculum (*lamina supraanalis*), and generally two anal valves (*valvulæ*) bounding it laterally, to which an inferior opercular piece is but rarely added.

The same number of segments as in *Blatta* occur in all Thysanura, particularly distinctly in *Machilis*, in which the tenth segment still forms a closed ring, while the strongly developed anal piece is distinguished by three long many-jointed appendages, of which the median one represents the anal operculum and the two lateral ones the cerci. In many of the lower insects and their larvæ we also find the same number of segments distinctly marked, as may be best recognized in the Acrydia and other Orthoptera, in the larvæ of Dragon-flies, &c.; even in the larva of *Hydrophilus* R. Heider has demonstrated the occurrence of ten true abdominal segments.

A comprehension of the variable constitution, especially of the abdomen, of the Hexapoda is possible only from the conception of the insect-body founded upon Hatschek's scheme. As will be shown, the divergent conditions can easily be referred back to the primitive condition, such as we have found in the above-mentioned Orthoptera, by citing both the dorsal and the ventral plates of the abdominal segments in simple numbers so far as they are independent and distinctly demonstrable, by furnishing these numbers above with a plus sign (+) when the plates are still distinct in the embryo, but in course of development become so aborted and suppressed that it usually requires special preparations to render them visible, furnishing them above with a minus sign (−) when the plates entirely disappear in the course of the development, and entirely omitting the numbers of those segments which are never formed even in the embryo; and lastly by indicating a secondary amalgamation by a uniting sign (⌒) and the anal piece by the letter A, seeing that it is homologous in all forms. As an example how by this schematization an insight into the course of the gradual reduction or amalga-

mation of the abdominal segments is rendered possible we may also take our Cockroaches.

In the almost completely developed embryo still enveloped in the egg-membranes (without the branchiiform appendages of the first ventral segment) a diminution of the number of the abdominal segments results from the tenth being suppressed, first ventrally and then dorsally, and, as was first demonstrated by Cholodkovsky *, finally having its dorsal plate amalgamated with the anal opercular plate †, when it is still recognizable in the adult male. Subsequently the occurrence of sexual maturity exercises an influence upon the last four segments, inasmuch as the tenth especially appears to be completely aborted in the female. The anterior nine dorsal plates remain in both sexes distinctly developed, rather less so certainly in the females, only the eighth and ninth are retracted somewhat under the seventh dorsal plate. While in the males the nine ventral plates remain developed until maturity, in the females the eighth plate first retreats over the seventh into the body and gradually becomes soft-skinned; then the ninth plate also passes into the body and over the seventh ventral plate; in *Periplaneta* the latter, having the middle of its hinder margin cut off by paired notches, finally grows into a shovel-like process which projects beyond the posterior segment and applies itself to the anal valves ‡. Thus in the mature females probably of all Cockroaches nine dorsal plates, but only the first seven ventral plates, are recognizable. By the retreat of the female sexual aperture, situated in the eighth ventral plate, a considerable space—the genital pouch—is produced; this is formed chiefly by the extended connective membrane between the elongated seventh and the eighth ventral plate. This serves for the development of the egg-cocoon which is retained by the internal appendages of the posterior gonapophyses.

A graphical representation of the divisions of the body of the mature female Cockroach may be furnished by the following number-sketch, in which the numbers standing above the line denote the dorsal and those beneath it the ventral shields of the abdomen §:—

$$\underbrace{\overline{\mathrm{Fr}+1,2,3}}_{\text{Head}} \qquad \underbrace{1,2,3}_{\text{Thorax}} \qquad \underbrace{\overset{++\ -}{1\text{—}7,8,9,10}}_{\overset{++\ -}{1\text{—}7,8,9,10}\ \mathrm{A}};$$

* Zeitschr. f. wiss. Zool. xlviii. (1889) p. 100.

† L. C. Miall and A. Denny ('The Cockroach,' 1886) inaccurately characterize this plate (p. 68 &c.) as the tenth dorsal shield.

‡ These "pedical plates" were regarded by Huxley as the terga of an eleventh abdominal segment.

§ Fr indicates the "frontal" and A the "anal piece."

on the other hand the formula for the abdomen of the male of *Phyllodromia*, for example, would be :—

$$\frac{1\text{—}7,\ 8,\ 9,\ 10\ \overset{++}{\frown}}{1\text{—}7,\ 8,\ 9,\ 10\ \overset{++}{-}}\ \text{A}.$$

The sexual differences extend also to the appendages of the anal piece. Thus in *Periplaneta orientalis* the anal valves of the male are also of a transversely triangular form, but considerably more feebly chitinized than those of the female; in the female of *Phyllodromia* they are similar but still more strongly developed, and they bear at their lower extremity a longitudinally-cleft plate, which is wanting on the soft-skinned, rather globular, anal swellings of the male. The sexual differences of the anal operculum (*lamina supraanalis*) have been long since employed in classification by H. Burmeister and C. Brunner von Wattenwyl.

The movable anal appendages (*cerci*), as already mentioned, resemble the cephalic antennæ in their formation, only they appear later and are less developed. In their structure and possession of sensorial setæ they also agree with the antennæ; nay, from V. Graber's * experiments upon decapitated cockroaches, their function would also seem to consist in the reception of olfactory stimuli. The number of joints in the cerci in the Kitchen-cockroach is 14–16, in the House-cockroach 9–11. In secondarily derived forms with a more globular abdomen the cerci decrease; thus, in the Panesthidæ, for example, in which the female presents only seven distinct dorsal and ventral plates, they appear only as short, inarticulate, triangular appendages. The late development and frequent reduction of the cerci seem to show that they are old inherited appendages which are approaching abortion (through disuse).

On the ninth ventral plate of all embryos and young animals of both the House- and the Kitchen-cockroach short, rigidly setose, unjointed appendages are to be seen which distinctly originate from the ninth segment †. In the female young forms of *Periplaneta* which are still destitute of rudiments of wings these *styles* may be detected even after the retractation of the last ventral plates; they are seated upon

* Biol. Centralbl. Bd. v. p. 452.

† Cholodkovsky (*l. c.* p. 94) ascribes their origin to the tenth segment and supposes them to become converted into the genital hooks of the male; both these views are founded upon errors of observation.

the chitinous plates, which may be recognized as the remains of the ninth ventral plate on each side of the short gonapophysial buds. In mature females (with wing-rudiments) the styles have entirely disappeared; thus they are probably cast off suddenly during a change of skin without being again produced, as no rudiments of them can be recognized.

In the mature males of *Periplaneta*, as in those of most exotic genera, the styles persist distinctly and symmetrically developed.

A want of symmetry in the ninth ventral plate already noticed by Brunner *, probably set up in the males of all forms with the completion of sexual maturity, consisting in a defect of the margin on one side, and an oblique inflection towards the dorsal surface, and probably to be ascribed to the strong development and projection of the long unciform titillator, often causes the reduction, but rarely the complete disappearance, of the styles. Thus in the adult male of the House-cockroach the styles occur only as small knobs, of which the larger left-hand one passes over about in the middle of the ventral plate, which is rendered unsymmetrical by a left-sided emargination; in *Ectobia* the right-hand style disappears entirely. These styles, although noticed by Brunner (*l. c.* p. 129), were entirely overlooked by Brehm † in *Periplaneta*. In many exotic genera the styles are quite rudimentary, as in the above-mentioned *Panesthia*.

The styles are rudimentary in a much greater degree than the cerci, although not such old structures. They occur in the same low grade of development elsewhere only in the males of certain families of the Orthoptera, in Mantidæ, and many Locustidæ, and are, as was first recognized by Wood Mason ‡, perfectly homologous with the abdominal styles which are seated upon the ninth ventral shield of many Thysanura (*Machilis*, *Lepisma*, *Lepismina*, *Nicoletia*), where they assist in the forward movement of the body, and also perform tactile functions; in young Cockroaches also we see them penetrated by strong nerves and muscles which gradually become rudimentary.

In opposition to these styliform appendages in their embryonic development are the gonapophyses, of which it need only be said that they make their appearance in the female only at the retractation of the eighth and ninth ventral plates in the form of processes in the neighbourhood of the sexual

* "Nouveau Système des Blattaires," in Verh. zool.-bot. Ges. in Wien, 1865, p. 15.

† Arb. Russ. Entom. Ges. 1879.

‡ Trans. Ent. Soc. Lond. 1879, p. 181.

aperture. The anterior pair of gonapophyses remains simple and originates on the eighth segment, while the posterior pair forks secondarily and springs from the ninth segment; the position of these gonapophyses therefore corresponds to that ascertained for the above-mentioned Thysanura, as well as the position of the parts of the ovipositor in Grasshoppers and Aculeate Hymenoptera, so that these appendages may probably be regarded as homologous structures.

On the other hand the paired uncinate hooks of the male of *Phyllodromia* appear to originate on the tenth ventral plate, so they should not be regarded as homologous with the developed valves of the penis in *Machilis*, which are seated upon the ninth abdominal ring, but, like the numerous other chitinous pieces around the male genital aperture, only as partial thickenings of the wall. These chitinous projections probably all serve to open and dilate the vagina of the female, especially as a perforated penis, which is highly developed in *Machilis*, seems to be wanting in the Blattidæ.

As Cholodkovsky proved, leg-rudiments perfectly homologous with the thoracic legs are formed in the young embryo from the first to the ninth abdominal segment. Of these embryonic appendages the first pair then become converted into peculiar branchiiform organs (*l. c.* p. 94), which disappear before the exclusion of the embryo; in fact on the first abdominal segment even of older embryos we find only the median ventral shield, which is surrounded by soft, transversely folded connective membrane. On the second to the ninth segments of the same stage the leg-rudiments undergo a plate-like change of form.

On the nearly mature embryo of *Phyllodromia* I find on the isolated ventral surface of the first abdominal segment only the median ventral shield representing the sternal plates of the thorax. On the second segment a median shield which is pretty strongly chitinized at the hinder margin also occurs in the middle, but on each side there is a plate more strongly chitinized, especially towards the lateral margin, but which is also covered with fine wavy wrinkles and short spines. The median ventral shield which is situated above the lateral plates is separated from the latter by delicate longitudinal folds, which may be traced distinctly as far as the seventh abdominal segment.

On the adult animal the tripartition of the ventral plate is distinctly retained only on the second abdominal segment, while the other ventral plates form a single shield on which no trace of longitudinal folds can any longer be recognized. Indications of this constitution of the ventral plates are still

to be found in *Periplaneta* and *Blabera* on the second abdominal segment; here the secondary transverse line * is interrupted in the middle, and only an indistinct demarcation of the median shield is to be recognized.

The peculiarities of the formation of the ventral plate above described in *Phyllodromia* are in correspondence with the remarkable condition of the ventral covering of the abdomen of *Machilis*, in which paired duplicatures which may be raised for half their length are united by flat anterior median shields.

Thus we get a fresh proof of the relationship of the Cockroaches with the Thysanura, which at the same time indicates that the ventral plates of the Hexapoda do not represent sternal shields of the same class any more than they correspond to the ventral shields of the Chilopoda, but that they are produced by the amalgamation of paired abdominal leg-rudiments flattened into plates with an unpaired median shield.

XXXV.—*Description of a new Genus of the Homopterous Family* Cicadidæ. By W. L. Distant.

In a collection of Rhynchota made in the Naga Hills by Mr. William Doherty, and which has just reached my hands, I was surprised and delighted to find another gorgeous addition to our knowledge of the Indian Cicadidæ, which again requires fresh generic subdivision. It is allied to the genus *Polyneura*; and as I have already passed that portion of the family in my Monograph, I describe it here and will subsequently figure it in the Appendix to my work.

Angamiana, gen. nov.

Body robust and elongate, broad and somewhat flattened. Head small, including eyes much narrower than pronotum, and narrower than base of mesonotum; ocelli much wider apart from eyes than from each other; face convex, slightly prominent above. Pronotum with the lateral and posterior margins very broad, the lateral margins strongly ampliated and obscurely angulated. Anterior femora distinctly and

* This fine transverse line, which divides the ventral shields of the abdomen into ventral plates and anterior shields, only originates later from the coalescence of delicate transverse wrinkles of the chitinous skin which is still soft.